able, half of it may well be spent in the study of elementary crystal optics so that minerals may be identified in slides. The above remarks apply especially to igneous rocks, as there is less variety in the sedimentaries and metamorphics and the loose nomenclature used for them makes them easier to classify. It may be urged that the broader chemical and geological features should be emphasized, that is, petrology rather than petrography should be taught. The writer is in entire accord with this view, but unless the student makes numerous rock analyses, how better can he learn to appreciate the chemical side of petrography than by a study of slides?

My views on this subject naturally depend somewhat upon my opinion of the recently proposed megascopic or field classification of igneous rocks. One of the serious criticisms applied to the ordinary qualitative classification is the redefinition of rock names. Yet in this field classification we have such names as syenite and basalt redefined to suit the megascopic determination. Perhaps the distinctions made on a megascopic basis are good ones, but terms that do not conflict with ordinary usage are preferable. Such names as leucophyrs are all right, but it seems hardly fair to call an anorthosite a syenite when the plagioclase may be determined at sight, since all its affinities are with the gabbros. It hardly seems reasonable to call a dark-colored porphyritic rock a basalt-porphyry when quartz or orthoclase phenocrysts are visible. Typical andesites can readily be distinguished and it hardly seems necessary to call them felsite-porphyries. The writer believes that the usually accepted grouping of igneous rocks into granites, rhyolites, syenites, trachytes, diorites, andesites, gabbros, diabases, basalts and peridotites is the best one to follow even in megascopic work. Of course one can not always make the distinctions recognized in this classification, but this is also true of any rock classification. Often one is fortunate if he can distinguish an igneous from a metamorphic rock in the hand specimen. One of the principal reasons for studying petrography is that the student may be able to read geological literature intelligently. Even though the ordinary classification is purely qualitative and the personal equation large, yet the names for the common rocks given above are fairly definite in their meaning as used in the literature for the last twenty-five years or so.

In conclusion the writer would summarize his views as follows: The purpose of the petrography course is to give the student a general idea of rocks, to enable him to make rough determinations of rocks at sight, and to help him in the understanding of geological literature. With these things in mind the study of hand-specimens and slides should go hand-in-hand. The student becomes familiar with the common rock types and so can determine other rocks by mental comparison with those he has studied in detail. The usual classification (granites, rhyolites, etc.) is suitable for megascopic determinations and is also the one recognized in the literature.

Austin F. Rogers
Laboratory of Mineralogy
and Petrography,
Stanford University

SCIENTIFIC BOOKS

The Mutation Theory. Volume I. "The Origin of Species by Mutation." By Hugo de Vries. English translation by Professor J. B. Farmer and A. D. Darbishire. Pp. xvi + 582. Four colored plates and 119 text-figures. Chicago, The Open Court Publishing Co. 1909.

The publication of the German work, "Die Mutationstheorie," by Hugo de Vries, marks an epoch, not only in the history of botany, but of all biological science; and the mutation-theory itself is, in all probability, the most important contribution to evolutionary thought since the publication of Darwin's "Origin." The importance of de Vries's work lies not only in the elaboration of the theory of saltation as an adequate method of the origination of new forms in the organic world, but (and more especially) in removing the entire question forever from the realm of ineffectual debate, and establishing it upon the firm basis of experimentation.

The general outlines of the mutation-theory are now so familiar to biologists that a statement of it here would be superfluous;[1] and yet the literature on the subject since the appearance of the first part of the German edition, in 1900, has so often shown a lack of clear understanding of the details and scope and claims of the theory, and especially, as the translators state (p. vi), of "a detailed knowledge of the contents of 'Die Mutationstheorie,'" that the English translation is most timely and most welcome. Many attempts have evidently been made to debate the questions involved without familiarity with the original work, and hence it may not seem out of place to emphasize here a few cardinal points which are daily becoming more generally correctly understood.

In the first place, "The special problem which the mutation theory seeks to explain is the manifold diversity of specific forms" (p. 45). It has long been recognized that natural selection really explains, not the origin of species, nor even the origin of adaptations, but the elimination of the unfit, and *the persistence of adaptations;* the fact that characters, both adaptive and non-adaptive, specific or not specific, must exist before they can be selected was previously well nigh lost sight of. The mutation-theory, then, seeks to account for *"the origin of specific characters"* (p. 211).

In the second place, "Spontaneous variations are the facts on which this explanation is based" (p. 45), or, "We may express . . . the essence of the mutation theory in the words: '*Species have arisen after the manner of so-called spontaneous variations*'" (p. 165). This marks the fundamental distinction between Darwinism and de Vriesism. For Darwin, specific characters originated, *chiefly* if not entirely, by the selection of fluctuating or continuous variations; for de Vries by discontinuous (*i. e.,* non-fluctuating) variation only. "In order that species may engage in competition with one another it is evidently an essential condition that they should already be in existence; the struggle only decides which of them shall survive and which shall disappear (p. 212).

The struggle which is significant in descent takes place, not between the individuals of the same elementary species, but between the various elementary species themselves (p. 211). The former results in acclimatization and the formation of local races (pp. 92–99 and 211); the latter in the elimination of unfit elementary species. "It is moreover evident that this 'elimination of species' must have weeded out many more than it has preserved. In a word, from the standpoint of the theory of mutation it is clear that the rôle played by natural selection in the origin of species is a destructive, and not a constructive one."

One of the commonest misconceptions of saltation is that the difference between mutation and fluctuating variation is a quantitative one; that mutations are large variations. Nothing could be more erroneous. The amount of the change has nothing to do with the question. "Many mutations are smaller than the differences between extreme variants" (of fluctuating variation) (p. 55). Mutations are characterized first, by being entirely *new* features, "In contradistinction to fluctuating variations which are merely of a *plus* or *minus* character (p. 213); second, by the *abruptness* with which they appear, and third, by being *transmitted by inheritance without selection.* "They arise suddenly and without any obvious cause; they increase and multiply because the new characters are inherited" (p. 212). "According to the theory of mutation species have not arisen gradually as the result of selection operating for hundreds, or thousands, of years, but discontinuously by sudden, *however small* changes" (p. 213; italics mine).

Moreover, de Vries has carefully defined the term species as used by him. This was never done by Darwin. There is evident need to emphasize this, for in many controversial papers it has been entirely overlooked, the critics meaning one thing by the term, de Vries

[1] Such a statement has previously been given in a review of de Vries's "Species and Varieties: their Origin by Mutation," *Plant World,* **8**: 86, 110, 135, 159. 1905.

and his followers quite another. Therefore, it is of prime importance to keep in mind the fact that with the species of the systematist the mutation theory has primarily nothing to do; and this fact is specifically stated. Thus, on page 165:

> In order to be qualified to discuss this question we must first of all make quite sure what we understand by the term "species" and, more important still, we must form a clear idea as to which forms we are going to regard as the units of the natural system. For it is only in the case of the *real* units of the system that we can hope to obtain experimental proof of their common descent: the theory of Descent as applied to groups of these units is, and will probably always remain, a comparative science.

And again, on page 168, it is insisted that:

> The ordinary Linnean species of the systematist . . . are artificial groups whose limits can be altered by the personal taste of any systematist and are indeed, as a matter of fact, much too often so altered. *The origin of such a species, like that of a genus, is a historical occurrence and it can neither be repeated experimentally, nor can the whole process be observed.* (Italics mine.) The object of an experimental treatment of these phenomena must assuredly be to make the origin of the units which really exist in nature the subject of experiment and observation. *We must deal not with the origin of the groups made by the systematist, but with those which are presented by nature.* (Italics mine.)

Thus the long-standing argument against organic evolution, that no one ever observed the origin of a species (of the systematist), is frankly acknowledged, but clearly shown to have no special significance for the theory of Descent. The elementary species, "those which are presented by nature," "do arise in the garden and in agricultural practise" (p. 169). This is no longer a debatable question.

It is absolutely essential clearly to understand the above points in order to discuss the mutation theory, or to undertake investigations in experimental evolution. It is worth repeating that, "The solution of this problem must . . . be sought among the facts themselves" (p. 462). As to whether mutations are realities or figments of imagination, no one is competent to hold an opinion who has never carried through a series of pedigreed cultures, or observed the results of such work.

Contrary to the implication of so many of his adverse critics, the author has tried to keep as close to Darwinian theory as the facts would permit. Throughout the book (cf., *e. g.*, pp. 51, 87, 198, 205) there has been a constant endeavor to give full credit to the great master, and to present the mutation theory, not as an alternative to natural selection, but as a supplementary hypothesis. Not Darwinism as a whole, but only the formerly baffling and embarrassing difficulties of Darwinism are explained away.

A perusal of the book before us recalls a list of many important and positive contributions rendered by the author through this and his numerous other related writings.

1. The application of the experimental method to the question of the origin of specific characters. This is justly regarded by de Vries as "the most important general result" of his work (p. 497).

2. The development of the method of pedigree-culture.

3. Making clear the fundamental distinction between fluctuation and saltation (mutation), and showing its prime importance. Just as Darwin was not the first to suggest natural selection, so de Vries was not, by any means, the first to draw the distinction between continuous and discontinuous variations (cf. p. 63); but, as was the case with Darwin, he stated the distinction so clearly, demonstrated it so convincingly, established it so firmly upon a wide range of facts, as to bring it into the focus of attention of all biologists, and compel them to reckon with it in all subsequent work.

4. Recognition of character units and of unit characters, and their significance; a principle fully developed in his "Intracellulare Pangenesis."

5. Actual observation of the origin of new plant-forms of the value of elementary species.

6. A resurvey of the vast literature of horticulture and experimental breeding, with a new interpretation of the facts in the light of a new working hypothesis (mutation).

7. Clearly stating, and securing general recognition of the difference between the origin of a character and its selection.

8. Formulation of the working hypothesis of pangenesis. *This was the parent-idea of the entire mutation-theory.*

9. Elaboration of the mutation-theory.

10. The unfolding of new problems and of entire new fields of research. The influence of the mutation-theory (like Darwin's "Origin") amounts to little less than a rejuvenescence of all biological science.

The English translation has had the advantage of the author's careful revision and correction, and embodies certain changes made necessary by Nilsson's work on the selection of cereals.

The second volume of the German original is in process of translation and will be eagerly awaited. Some of the more technical chapters of this volume, relating to hybridization, will be omitted and their translation published separately.

English-speaking botanists and zoologists owe a debt of sincere gratitude to Professor Farmer and Mr. Darbishire for rendering so invaluable a book into their native language. The press work is also commendable, and we should appreciate the willingness of the publishers to undertake the publication of so extensive a work of this character. It is easier to get this done in almost any other country than in the United States.

C. STUART GAGER

DEPARTMENT OF BOTANY,
UNIVERSITY OF MISSOURI

The Story of the Submarine. By Colonel CYRIL FIELD, R.M.N.I.

This is a popular review of the history and traditions of submarine warfare and navigation from the earliest ages to the present day. The manner of presentation is well conceived and the illustrations are sufficient, without going too far into detail. The traditional part appears to be drawn from medieval marvel mongers who never missed a good story nor spoiled it by leaving out picturesque details. But by the second chapter the author takes up his history in which he is precise and conscientious. In the middle of the seventeenth century real submarines were built and navigated, but the progress was slow and intermittent, since they were almost all made of wood and propelled by hand, even so late as the middle of the nineteenth century. The form of the submarine and the difficulties of submarine navigation were by that time fairly well understood, but the lack of mechanical propulsion made the increase of size of little avail.

The author's strict adherence to chronological order fails to throw into relief the really essential features of the development of submarines, such as the chemical generation of oxygen by Payerne, the application of steam power by Garrett and the introduction of the storage battery by Goubet. In the same way the development of the submarine in France and in America loses connection from the fact that first one and then the other comes up for discussion.

The modern submarines appear to be possible on account of the combination of the internal combustion engine (used by Holland), the storage battery, together with devices for controlling direction and submersion. Each of them is described in its proper place, but the reader is left to recognize the combination. In like manner the submarine torpedo is described as the proper weapon of the submarine, but its direct influence on the development of the submarine, due to the perfection of control of the torpedo, is not mentioned.

The author's description of the submarine of to-day is sufficient for his "man in the street," and one may charge to official secrecy and rapidity of development his failure to distinguish clearly between submarines and submersibles and why the latter have been developed to such a displacement of 1,000 tons with a speed of sixteen knots at the surface. His conservative estimate of the importance of the submarine and of its use for other than warlike purposes must be respected.

C. H. PEABODY

MASSACHUSETTS INSTITUTE
OF TECHNOLOGY